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Multiattribute Utility Analysis as a Framework for Public Participation -- Siting a Hazardous Waste Facility

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Abstract

In an attempt to facilitate the resolution of contentious environmental problems, public agencies are increasingly using collaborative approaches wherein stakeholders participate in the decision-making process. A dilemma for the design of collaborative approaches is the technical complexity of many environmental problems. How can members of the public play a meaningful role in decisions that involve complicated scientific arguments?

This paper describes a public participation exercise in which stakeholders used an approach based on multiattribute utility analysis to select a site for a hazardous waste facility. Key to success was the ability to separate and address the two types of judgments inherent in environmental decisions--technical judgments regarding the likely consequences of alternative choices and value judgments regarding the importance or seriousness of those consequences. The approach enabled technical specialists to communicate the essential technical considerations and allowed stakeholders to establish the value judgments for the decision. Although rarely used in public participation, the multiattribute utility approach appears to provide a useful framework for the collaborative resolution of many complex environmental decision problems.

KEY WORDS: Multiattribute utility analysis; Public involvement; Collaboration; Dispute resolution; Environmental management

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Efforts to involve stakeholders in environmental decisions are on the increase. Various collaborative models for decision making are being explored which empower stakeholders to take collective responsibility for decisions (Selin and Chavez 1995). In theory, public participation improves the quality of decisions and lessens opposition to the choices that are made. However, a significant barrier to success is often the technical complexity of the environmental problem. Environmental professionals are reluctant to share decision-making responsibility with individuals who lack understanding of key technical considerations. Members of the public distrust the motives of environmental professionals who justify their preferences using incomprehensible technical arguments.

This paper illustrates an approach to public participation based on multiattribute utility analysis (MUA). The approach was used by Sandia National Laboratories (SNL) in New Mexico to involve stakeholders in an important technical decision associated with its Environmental Restoration (ER) Project. The decision was where to locate a Corrective Action Management Unit (CAMU), a facility intended to consolidate and store wastes generated from the cleanup of hazardous waste sites. Although rarely applied with stakeholder participation, MUA proved surprisingly effective. It produced a consensus over a selected site and enhanced public trust and understanding of Sandia's environmental restoration activities.

CAMU Working Group

The effort began with the formation of a CAMU Working Group, a group of about 20 individuals willing to attend two, one-day meetings to evaluate and rank alternative sites for the CAMU. Group members were self-selected from existing stakeholder organizations, including the Sandia Citizens Advisory Board (CAB), the New Mexico State Environment Department (NMED), the Department of Energy (DOE), the Environmental Protection Agency (EPA), SNL, and the public at large. Except for the SNL representatives and regulators, few members of the Group had experience or detailed understanding of CAMU siting issues, and many had little or no applicable technical training.

Candidate Sites

To provide siting options, EPA and SNL criteria for CAMU siting were used to screen an initial list of 156 potential siting locations down to five feasible options. Figure 1 shows the locations of the five candidate sites labeled 18, 74, 107, 240, and 241.

Site Ranking Process

~~Multiattribute utility analysis (~~MUA) was used to conduct the key step of ranking the five candidate sites. MUA is a formal approach for using multiple criteria to evaluate options (Keeney and Raiffa 1976). Various tools, techniques, and software for facilitating the implementation of MUA have been recently developed by a team of representatives from SNL, Los Alamos National Laboratory, and Lawrence Livermore National Laboratory as part of a formal priority setting process know as the Laboratory Integration and Prioritization System (LIPS) (Anderson and others 1994). LIPS techniques were used in this application.

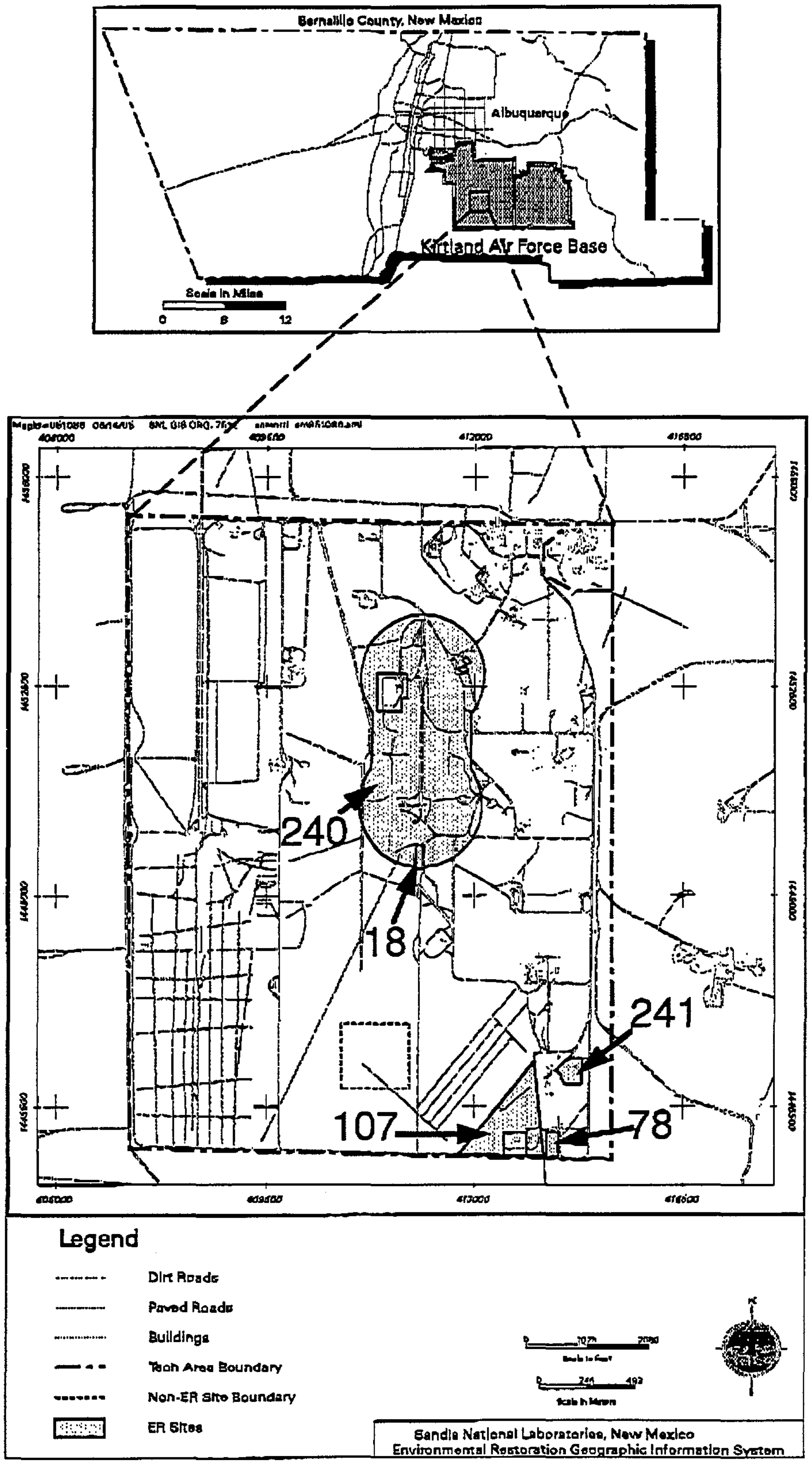

Figure 1. Candidate sites

Numerous technical requirements must be satisfied to properly apply MUA (Keeney 1982). However, in its simplest form, the basic steps are:

1. Identify decision objectives.
2. Establish attributes and rating scales for measuring the degree to which options achieve objectives.
3. Assess weights and other value judgments specifying the relative importance of achieving the objectives.
4. Combine weights and ratings to obtain an overall measure of the desirability of each option.

Although MUA has been applied previously to siting decisions (e.g., Merkhofer and Keeney 1987), it has only rarely been used as a means for involving the public and other stakeholders in public-policy decisions (Lathrop, 1992).

First Meeting with the Working Group

At the first meeting, a facilitator who was an expert in MUA led participants through the process of identifying objectives for the site-selection decision. The question was, "What, exactly, does a good CAMU site need to do?" Even the least technical participants found it easy to participate in this step. After some discussion, it was agreed that the selected site needs to: (1) protect public and worker health and safety, (2) minimize adverse impacts to the natural environment, (3) meet the necessary technical and regulatory requirements to enable the site to serve as a CAMU, and (4) ensure effective and efficient use of resources, including land, money, and time. These objectives were displayed for the Group as a hierarchy of site-selection criteria, shown in Figure 2.

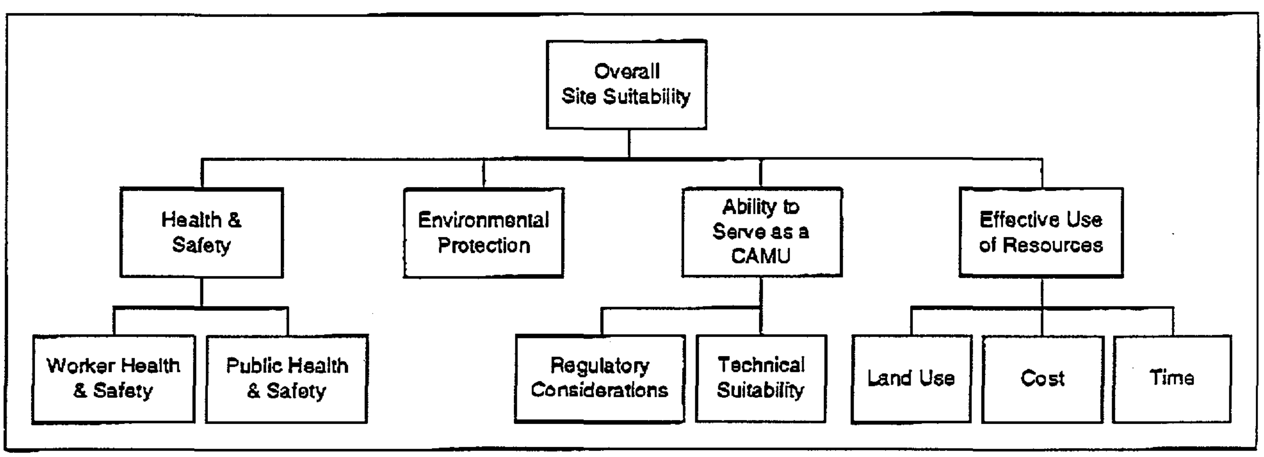

Figure 2. Criteria hierarchy

Next, discussion was directed towards identifying site characteristics and other factors that influence how well sites perform against the criteria. The facilitator posed questions such as "What determines the level of risk to the public from the CAMU?" Given the technical nature of this topic, SNL participants dominated these discussions.

A computer program for constructing and displaying influence diagrams (ADA Decision Systems 1995) was used to document the identified factors and their relationships. Influence diagrams graphically display the influences among factors relevant to a decision, and they are useful for selecting the attributes and rating scales for MUA (Merkhofer 1990). Participants first agreed on the factors influencing each criterion and then identified the factor or factors judged to be the most useful site discriminators. Although technical specialists developed the diagrams, non-technical participants asked many questions and quickly understood the logic represented by the influence diagrams.

Figure 3 provides an example of one of the influence diagrams. It shows the consensus influence diagram for the criterion related to public health and safety. The asterisk by the factor labeled "distance to existing communities" indicates that distance (measured in miles) was agreed to be a useful discriminator for the public health criterion. Due to the similar geological and hydrological characteristics of the candidate sites, the other factors shown in the diagram were agreed by participants not to differ significantly from site to site.

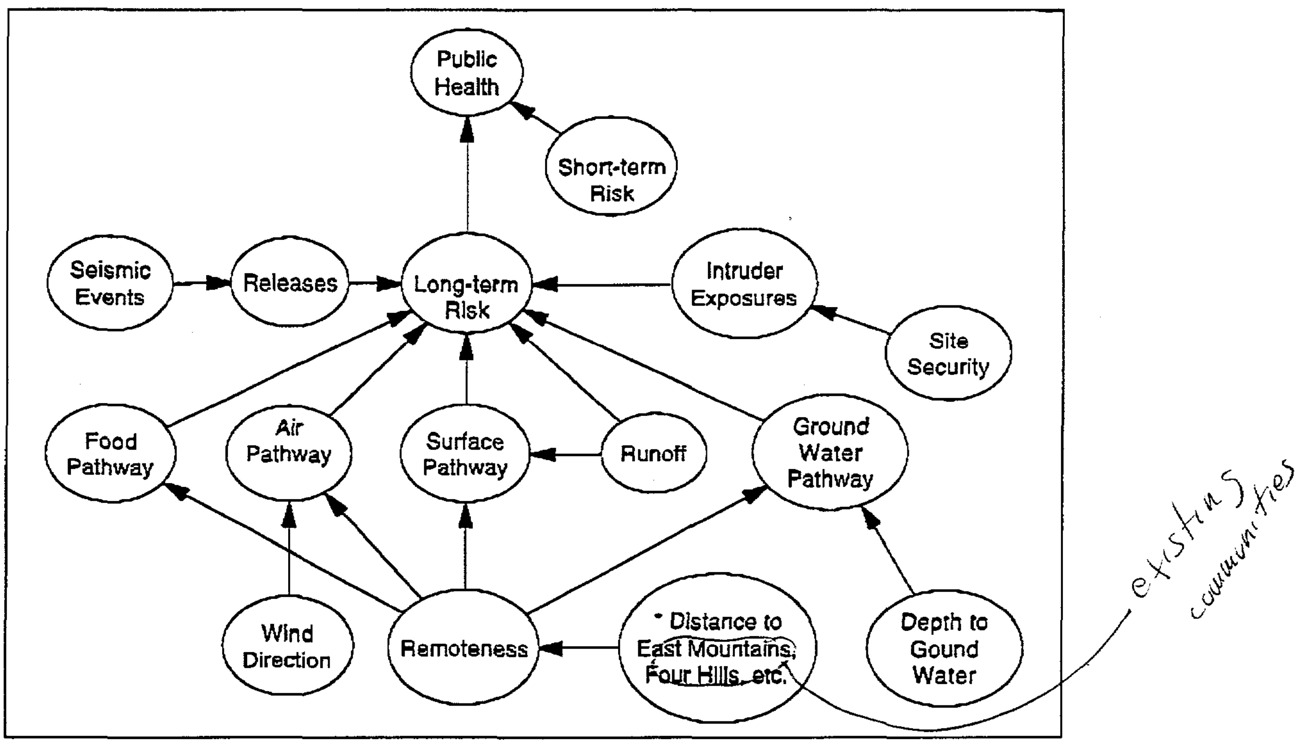

Figure 3. Influence diagram for public health

In the interval between the first and second meetings, 1-to-5 rating scales were developed for each of seven factors identified as useful discriminators. In each case, the middle level 3 was defined as the average for the sites, levels 1 and 5 were specified to encompass the range of possibilities, and the levels were defined to represent approximately equal (value) increments of performance. For example, the scale for distance was based on the distance (in miles) between the site and the nearest public community. Level 3 was defined as the average (e.g., 4 miles), levels 2 and 1 were specified as above average (e.g., 5 miles and 6 miles, respectively), and levels 4 and 5 were specified as below average (e.g., 3 miles and 2 miles, respectively). The scales, together with scoring instructions, were provided to the SNL technical participants who used the scales to rate each site.

Second Meeting

To begin the second session, participants were provided with a tour of the candidate sites. After returning to the meeting room, the rating scales were presented to and accepted by the group. SNL participants explained the reasoning that each had used to score the sites on the rating scales. After a question and answer period, the external stakeholders individually scored the sites, using the same scales but applying their own judgments.

Finally, weights were used to combine the ratings on the various factors into an overall measure of performance. Weights were assessed from participants using a technique that ensures consistency between the weights and the ranges of possibilities expressed in the rating scales (von Winterfeldt and Edwards 1986). Neither weights nor ratings were averaged across individuals, so that differences in opinion over the rankings could be traced to differences in ratings, which reflect technical judgments, or differences in weights, which reflect value judgments. This distinction was regarded by participants as important. Although some stakeholders acknowledged that their ratings might be less valid due to their limited technical expertise, all felt that their value judgments were at least as valid as those provided by technical specialists. At least one stakeholder commented that he anticipated major disagreements between the rankings obtained from the technical specialists and stakeholders, based on differences in weights. In particular, he questioned the relatively low weight assigned by technical specialists to the distance of the site from communities and argued that his weights represented a "less arrogant" level of confidence in the CAMU.

Results

The results of the prioritizations for the various participants were surprising similar. As shown in Table 1, regardless of how the ratings and weights were combined, the resulting site ranking remained the same. Site 74 was clearly an inferior site. The other four candidates were closely matched, and Site 107 was a narrow, but consistent, winner. Site 107, an area once used for testing high explosives, was a relatively remote site which did reasonably well on all criteria. It had not previously been perceived by the technical specialists as a clear favorite because it was the only one of the five sites with contamination levels sufficiently low that it might potentially qualify under regulatory requirements for no further action (NFA). The logic of the analysis suggested that this consideration was not sufficient to outweigh the positive characteristics of the site.

When asked to comment, each participant stated that the numerical rankings matched their personal, intuitive site rankings. A unanimous opinion was expressed that Site 107 was indeed the preferred choice. Participants also expressed enthusiasm for the process. Comments included, "I really felt as though we did a thorough job," "What we did was common sense," and "Sandia should use this approach more often."

Table 1. CAMU site selection summary of overall performance

Site	Avgs. of All Weights and All Scores	Avgs. of Technical Weights and All Scores	Avgs. of Technical Weights and Technical Scores	Avgs. of External Stakeholder Weights and All Scores	Avgs. of External Stakeholder Weights and External Stakeholder Scores
18	90	90	**89**	90	90
74	83	83	82	84	83
107	**91**	**91**	**89**	**91**	**91**
240	89	88	87	89	89
241	88	88	88	88	87

Note: Overall performance is measured on a zero-to-100 scale rounded to nearest point. Highest score in each category is boldfaced.

Summary and Conclusions

The approach was successful because:

- It was simple and readily understandable to participants. It made sense.
- It focused discussion on the issues that really mattered. Although it identified areas of disagreement, it demonstrated broad agreement over the course of action.
- It provided participants with a meaningful and important role in the decision process.

The MUA approach provided a framework that differentiated available options, identified relevant technical considerations, clarified essential value judgments, and efficiently communicated these elements among stakeholders. Stakeholders participated effectively even though they had limited understanding of the technical details. By involving stakeholders in the design of the decision model, a sense of ownership and confidence in the process was produced.

Admittedly, one success does not prove the general usefulness of the approach. Success, in this case, was obviously aided by the fact that rankings were insensitive to weightings. However, logic can be a powerful force for consensus. By using a logical, structured framework for analyzing decision options, stakeholder involvement can be an investment with considerable benefits.

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